



# Main Injector 150 GeV flat-top Lattice Measurement

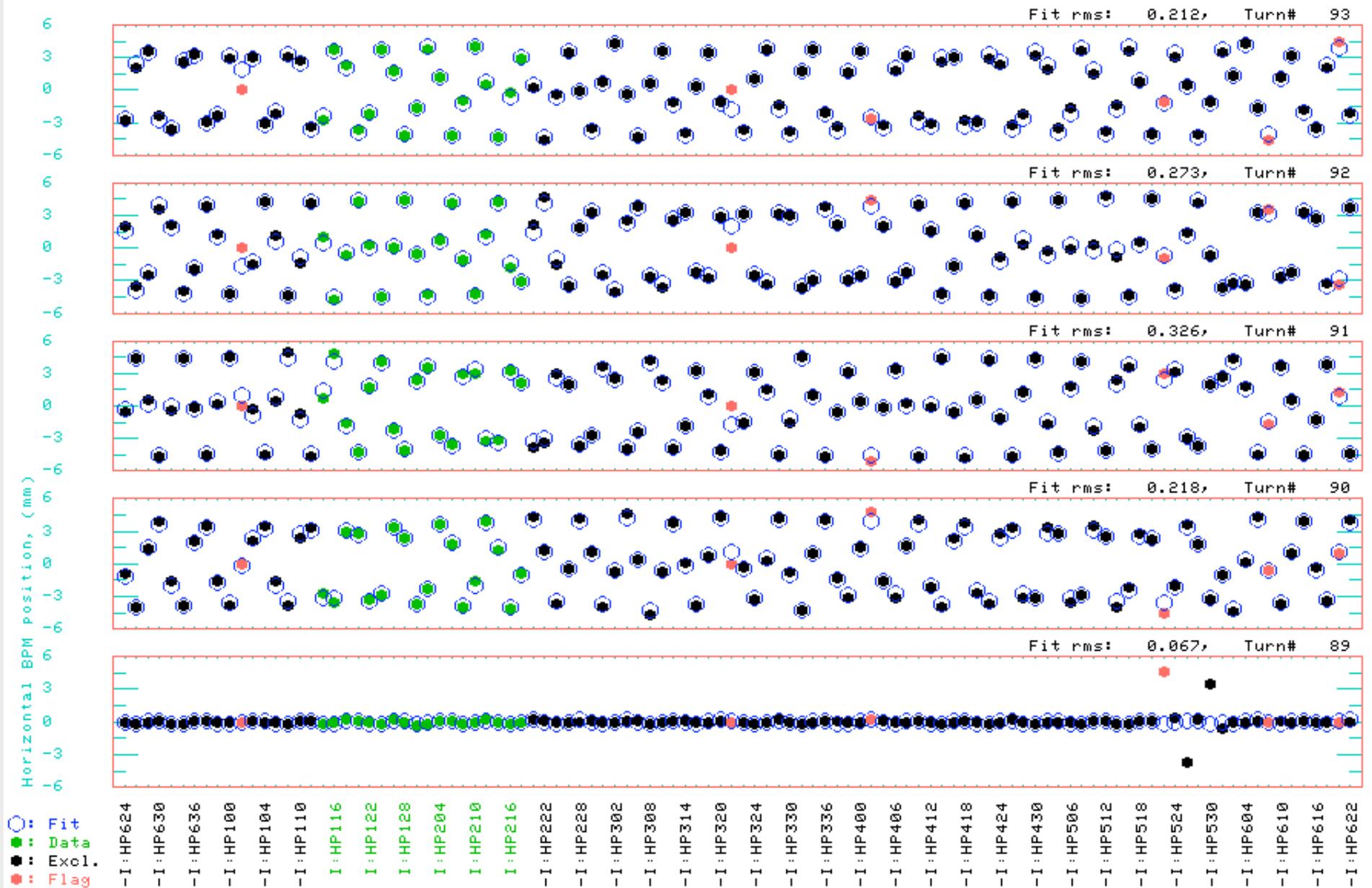
Ming-Jen Yang  
04/04/2007

# Study

- ❖ Took data on \$2B
  - ▶ TLG module # 193.
  - ▶ Beam to MI dump.
  - ▶ Intensity at 4 Booster turn and 40 bunches.
- ❖ Horizontal plane
  - ▶ Use MI52 kicker
  - ▶ Pinged beam at flat-top, 10 KV.
    - ~4 mm oscillation.
- ❖ Vertical plane
  - ▶ Use all 3 MI10 kickers.
  - ▶ Total kick of 9KV, i.e 3KV for each kicker.
    - ~2.5 mm oscillation.

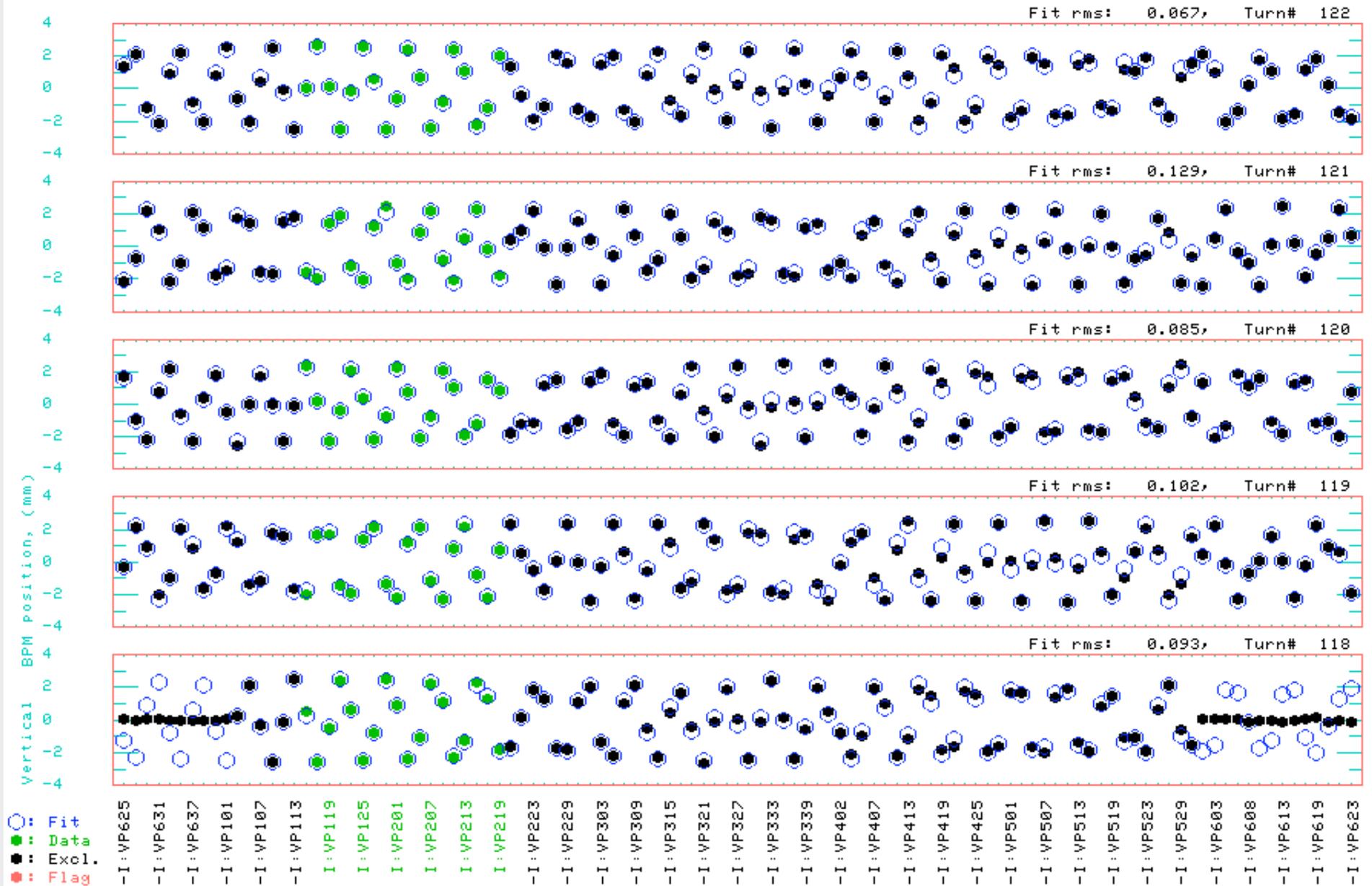
# TBT positions, horizontal

(mi150\_070413\_horz3.tbt) 13-APR-07 11:57:06 150 GeV, 10KV, .9E12, horz



# TBT positions, vertical

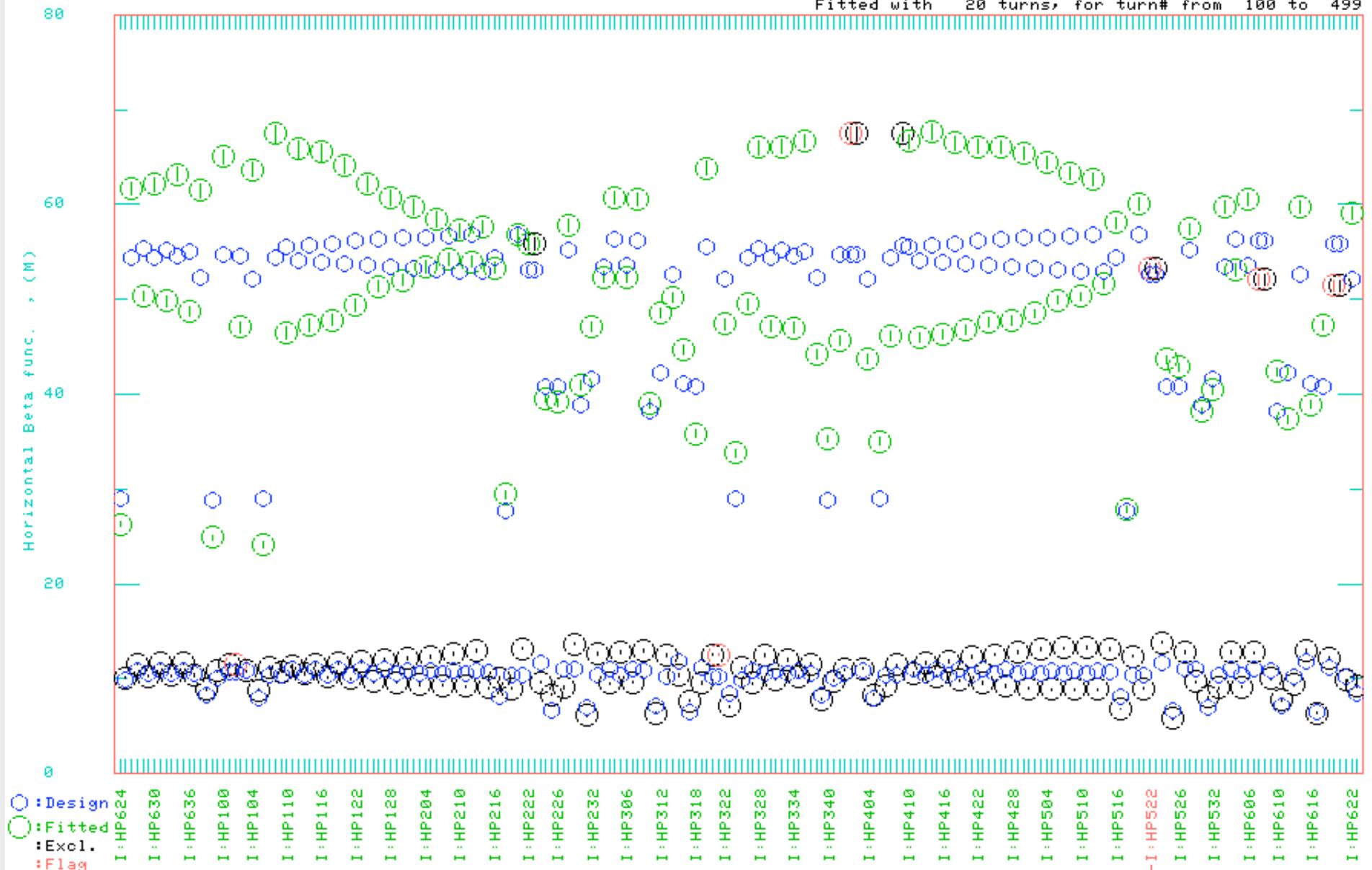
(mi150\_070413\_vert2.tbt) 13-APR-07 12:17:16 150 GeV, 9KV, VERT



# MI beta at 120 GeV, horizontal

(mi150\_070413\_horz3.tbt) 13-APR-07 11:57:06 150 GeV, 10KV, .9E12, horz

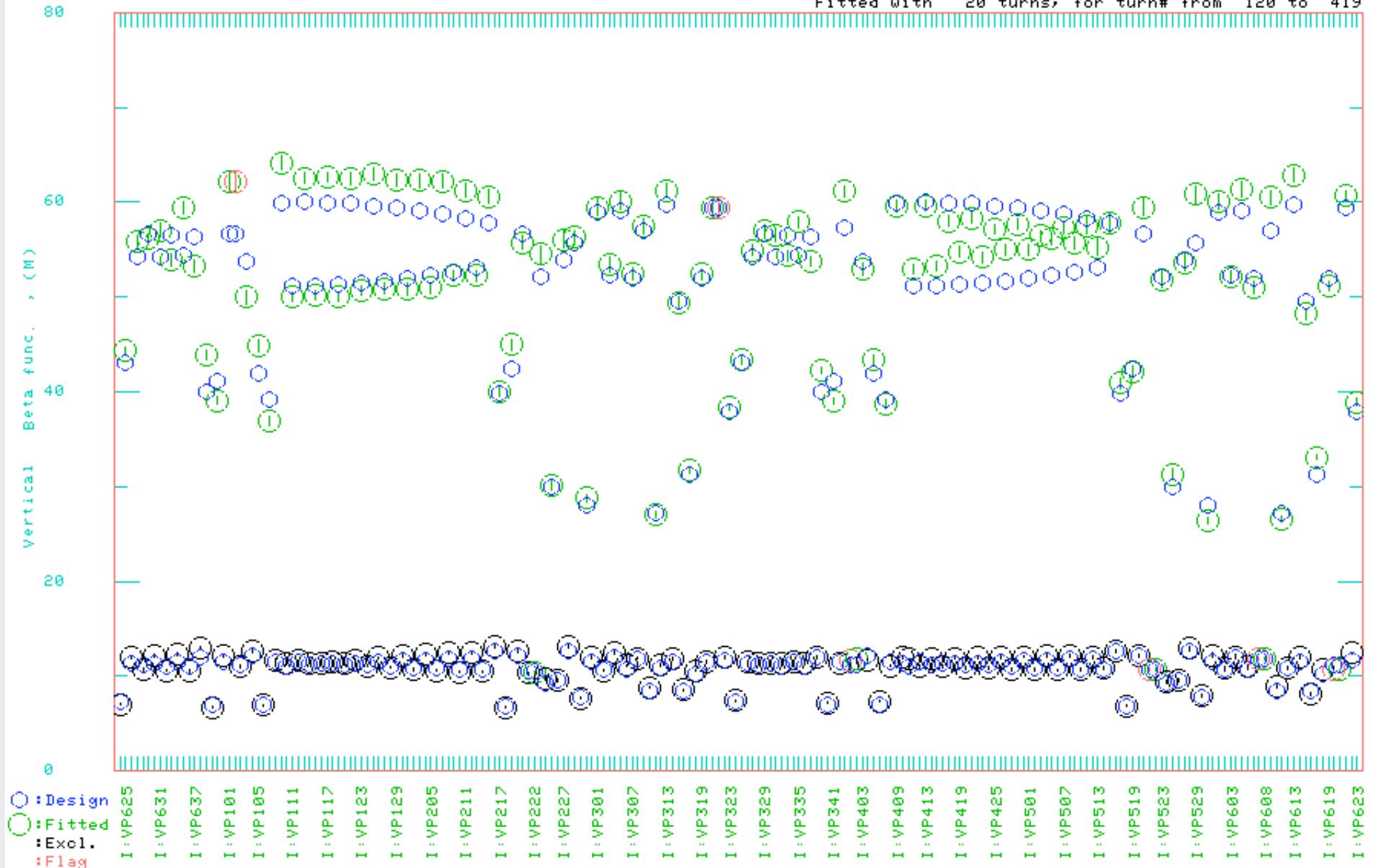
Fitted with 20 turns, for turn# from 100 to 499



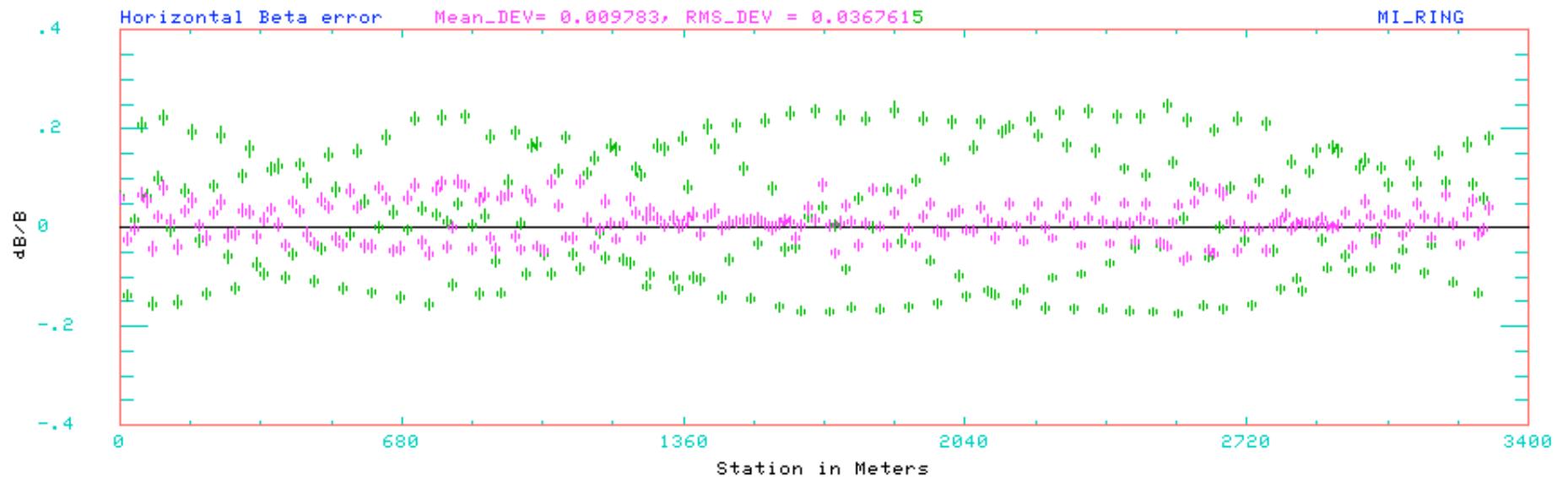
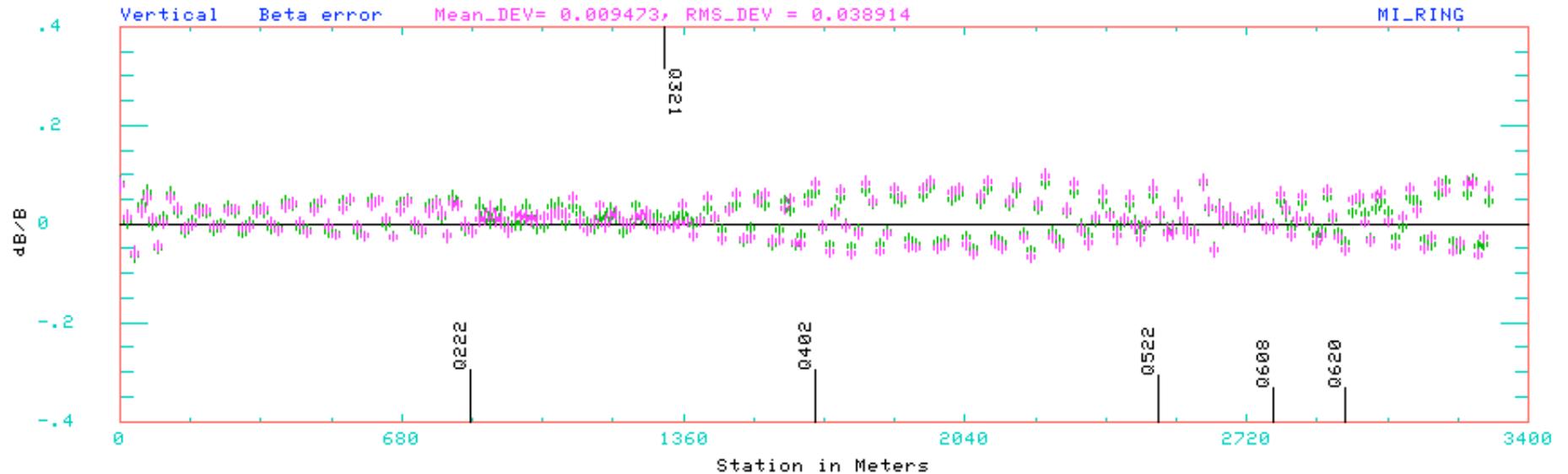
# MI beta at 120 GeV, vertical

(mi150\_070413\_vert2.tbt) 13-APR-07 12:17:16 150 GeV, 9KV, VERT

Fitted with 20 turns, for turn# from 120 to 419



# Horizontal & vertical Beta errors



# Trim current used for WQB

Z1 Beam line analysis--Main Injector 17-APR-07 14:56:42 \*Pgm\_Tools\*

functions    setup    data    calculate    display    Misc

Lattice parameters

Select: [MI\_RING ] as [Synchrotron ]  
 Start at element: [VP601 ] for [Proton ]  
 \*Track: [Lattice function] at ( 8 ) GeV

Lattice    Horz    Vert  
 Phase: ( 26.4204 ) ( 25.3797 ) 2π  
 Beta: ( 8.46257 ) ( 59.62 ) M

\*Device type: [Quad ]  
 \*Attribute: [DataBase ]  
 \*Mode: [Modify]

DB device page

DB_name	Setting	prev_set	reading	prev_read
I:QT101	Amps 0		1.5	0
I:QT222	Amps 0		3.5	0
I:QT321	Amps 0		-1.8	0
I:QT402	Amps 0		3.1	0
I:QT522	Amps 0		-2.8	0
I:QT608	Amps 0		-3.3	0
I:QT620	Amps 0		-3.3	0
I_Q101	Amps 0		-207.2255	-207.224
I_Q222	AMPS 0		213.8891	213.8712
I_Q321	AMPS 0		-203.9255	-203.924
I_Q402	Amps 0		213.4891	213.4712
I_Q522	Amps 0		207.5891	207.5712
I_Q608	AMPS 0		207.0891	207.0712
I_Q620	AMPS 0		207.0891	207.0712
I:IQD	Amps		205.7255	205.724
I:IQF	Amps		210.3891	210.3712

\*Page length: [ 57 ]    \*History depth:[15]

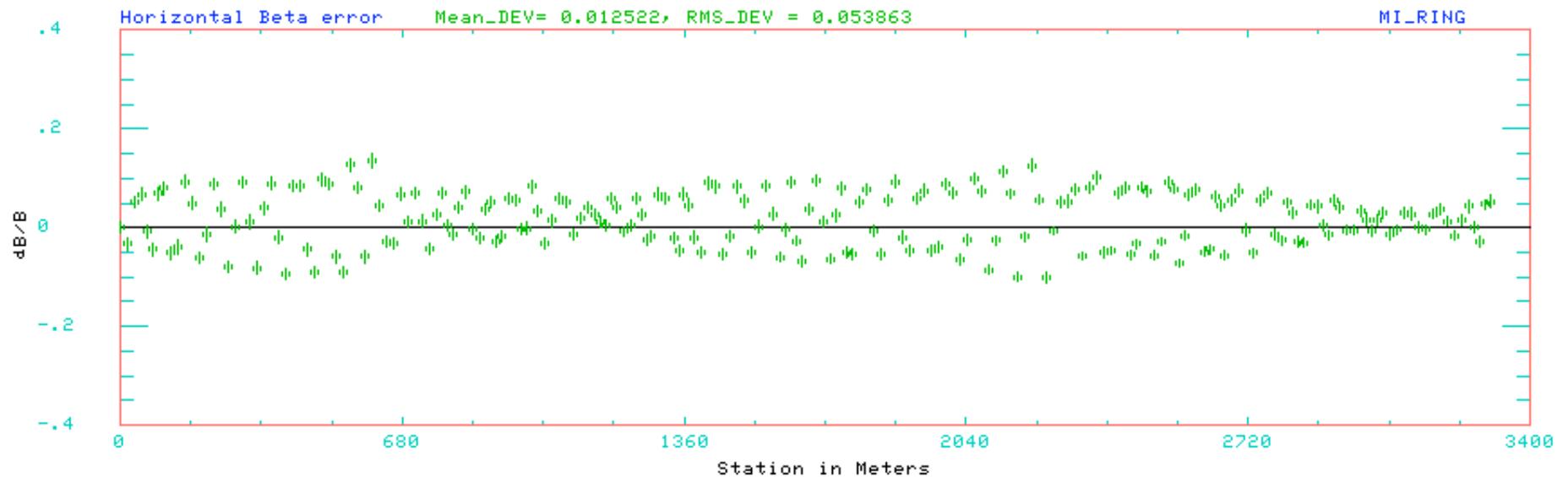
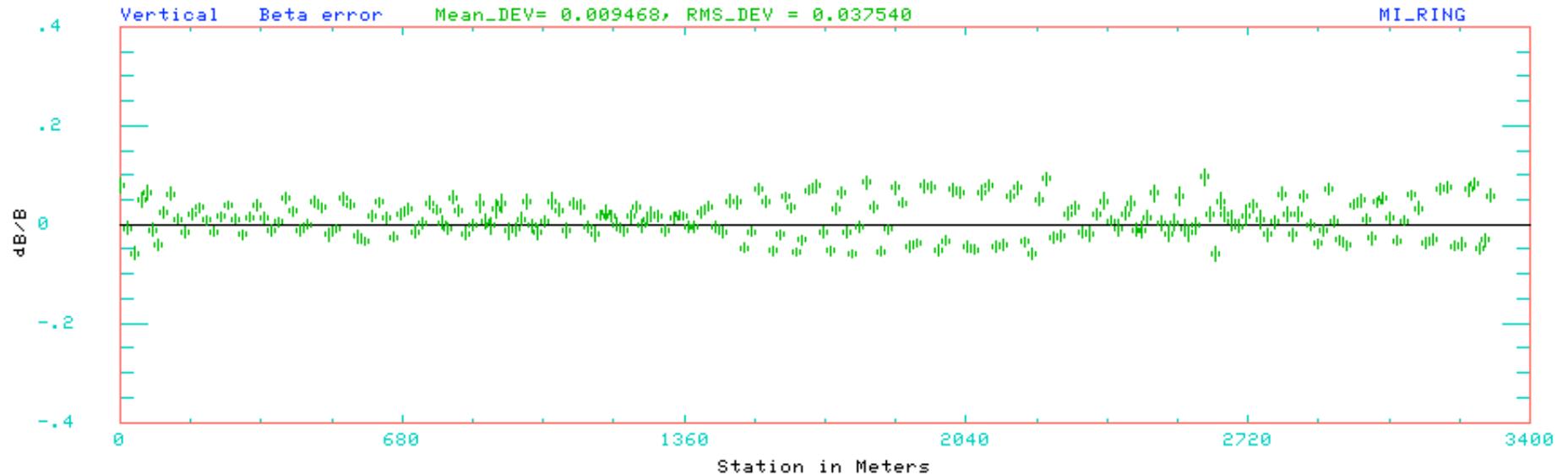
1:20 of 57

adjusted to get operation tune

Calculation is 8-GeV equivalent

$\times \frac{150.9}{8.9}$

# Matching error with harmonic quads



# Harmonic quad settings

Z1 Beam line analysis--Main Injector 20-APR-07 09:24:32 \*Pgm\_Tools\*

functions    setup    data    calculate    display    Misc

Lattice parameters

Select: [MI\_RING ] as [Synchrotron ]  
 I Start at element: [VP601 ] for [Proton ] ] ]  
 A \*Track: [Lattice function] at ( 8 ) GeV ] ]  
 \*T S Lattice    Horz    Vert  
 \*R Phase: ( 26.4204 ) ( 25.3797 ) 2π ← /B  
 M Beta: ( 9.57886 ) ( 58.9159 ) M ← /B

\*Device type: [Quad ]  
 \*Attribute: [DataBase ]  
 \*Mode: [Modify]

DB device page

\*Page length: [ 57 ]    \*History depth:[15]

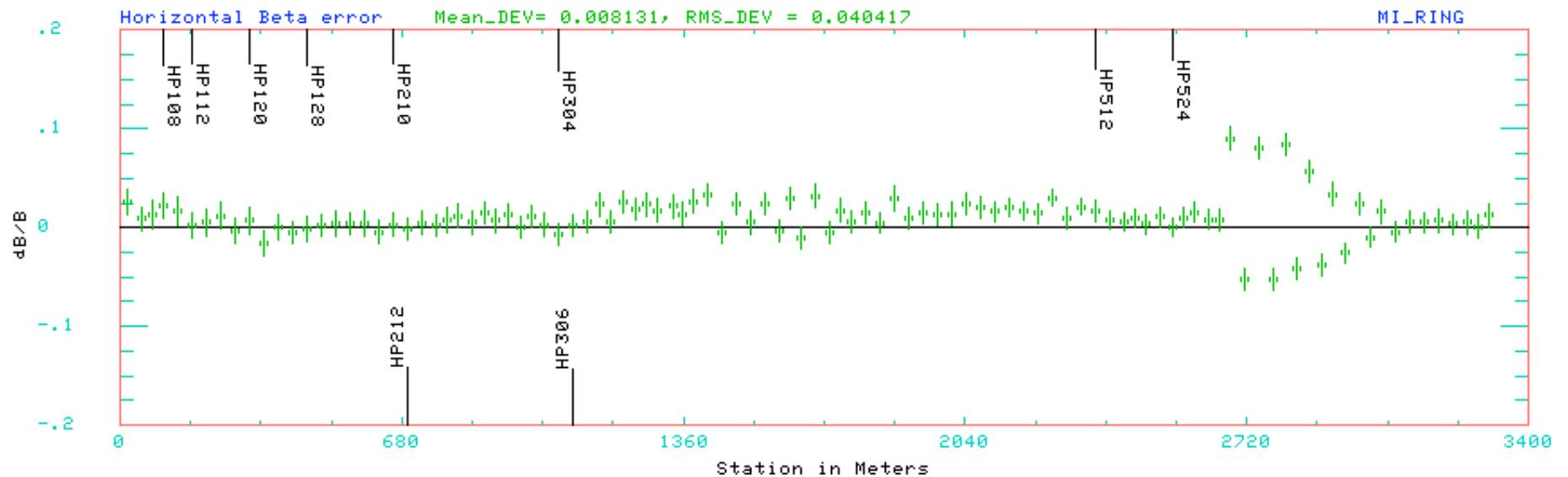
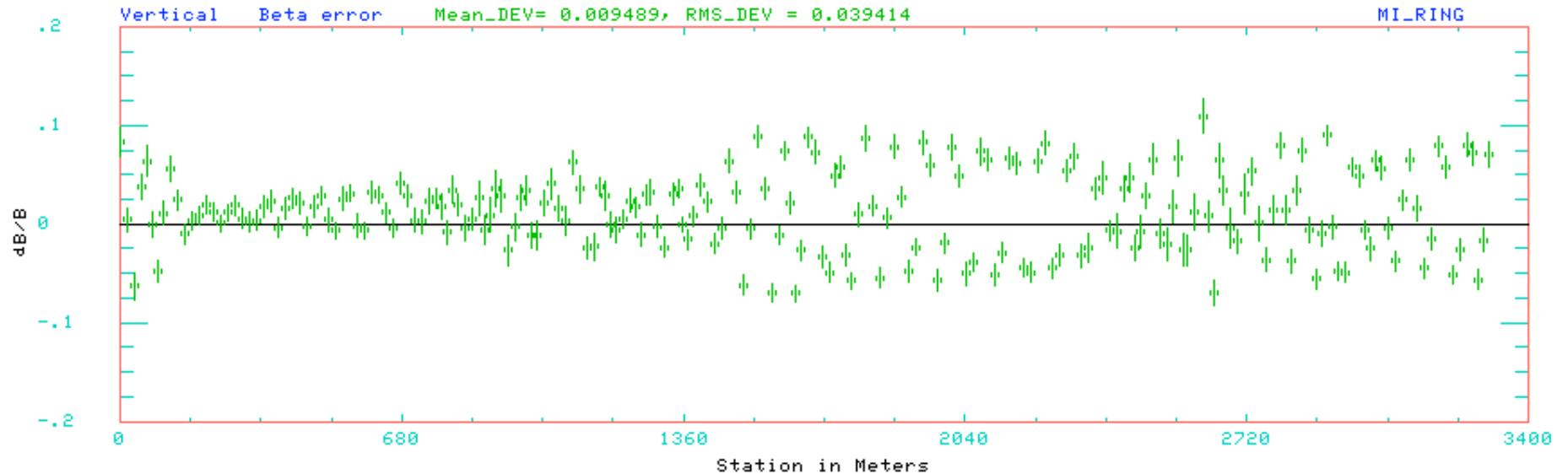
DB_name	Setting	prev_set	reading	prev_read
I:IQD	Amps		205.7319	205.7317
I:IQF	Amps		210.1372	210.1362
I:QC206	Amps 0		3.8	3.7
I:QC208	Amps 0		1.6	1.5
I:QC210	Amps 0		.5	.4
I:QC212	Amps 0		1.8	1.7
x_QC506	Amps 0		-1.5	-1.6
x_QC508	AMPS 0		1.9	2
x_QC510	AMPS 0		2.5	2.4
x_QC512	AMPS 0		0	.1
I:QT101	Amps 0		0	-1
I:QT222	Amps 0		0	.3
I:QT321	Amps 0		0	-.3
I:QT402	Amps 0		0	2.6
I:QT522	Amps 0		0	1.8
I:QT608	Amps 0		0	-.4
I:QT620	Amps 0		0	-.4

adjusted to get operation tune

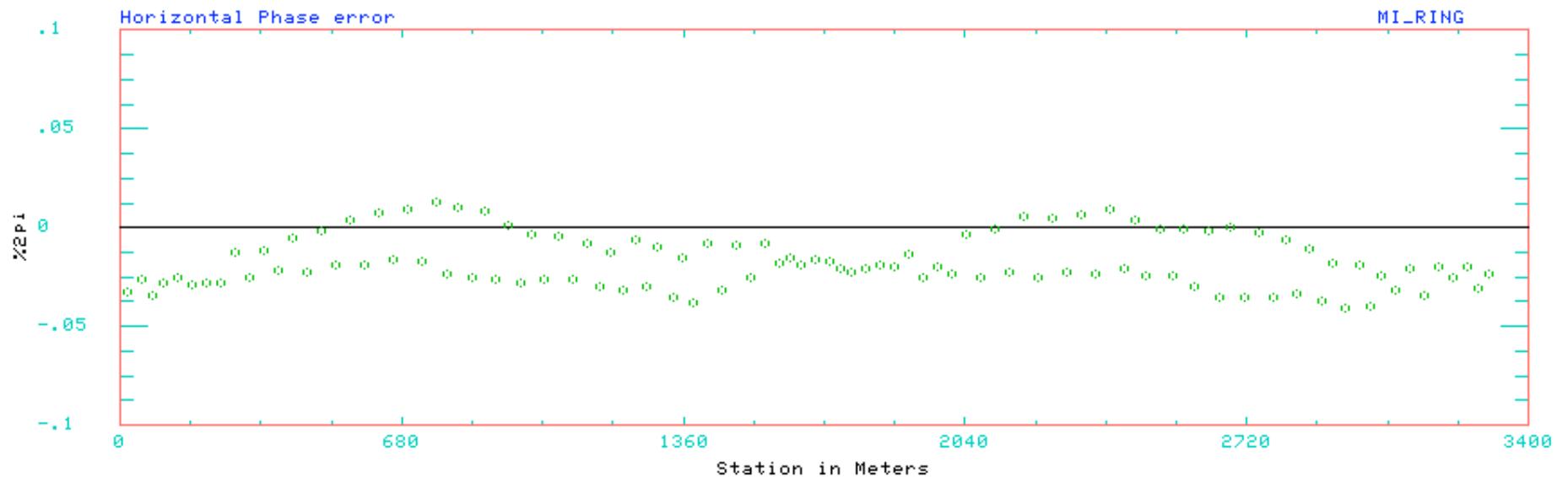
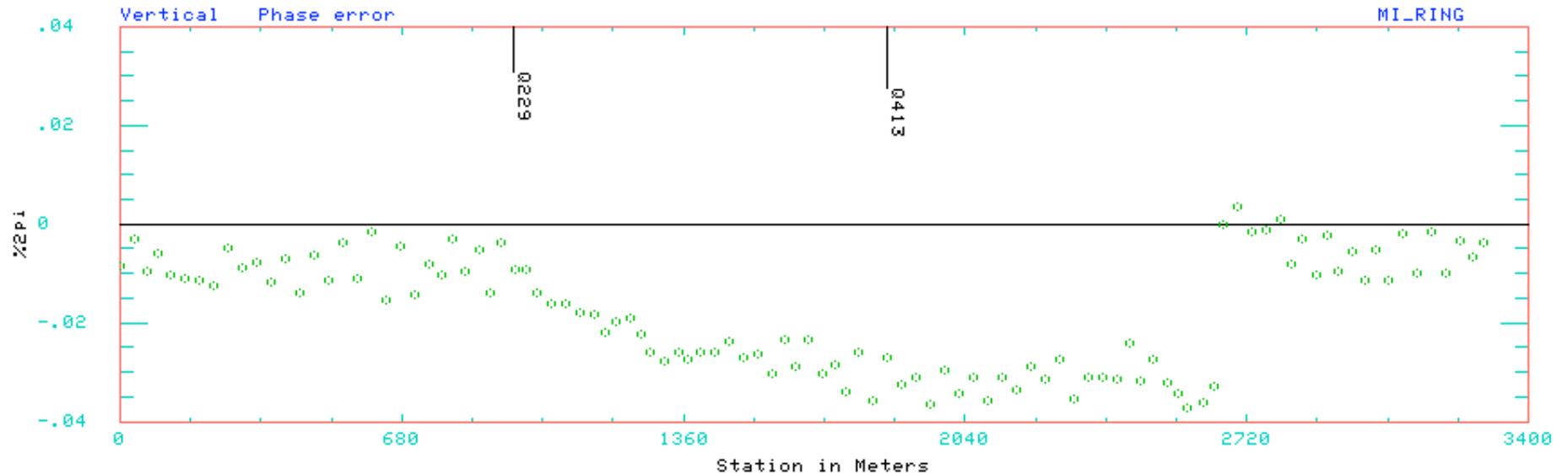
DBDEV: I\_Q101 is  
 DBDEV: MIQB\_D is  
 PA1676 running on Con <Exit>

1:20 of 57  
 1:3 of 5

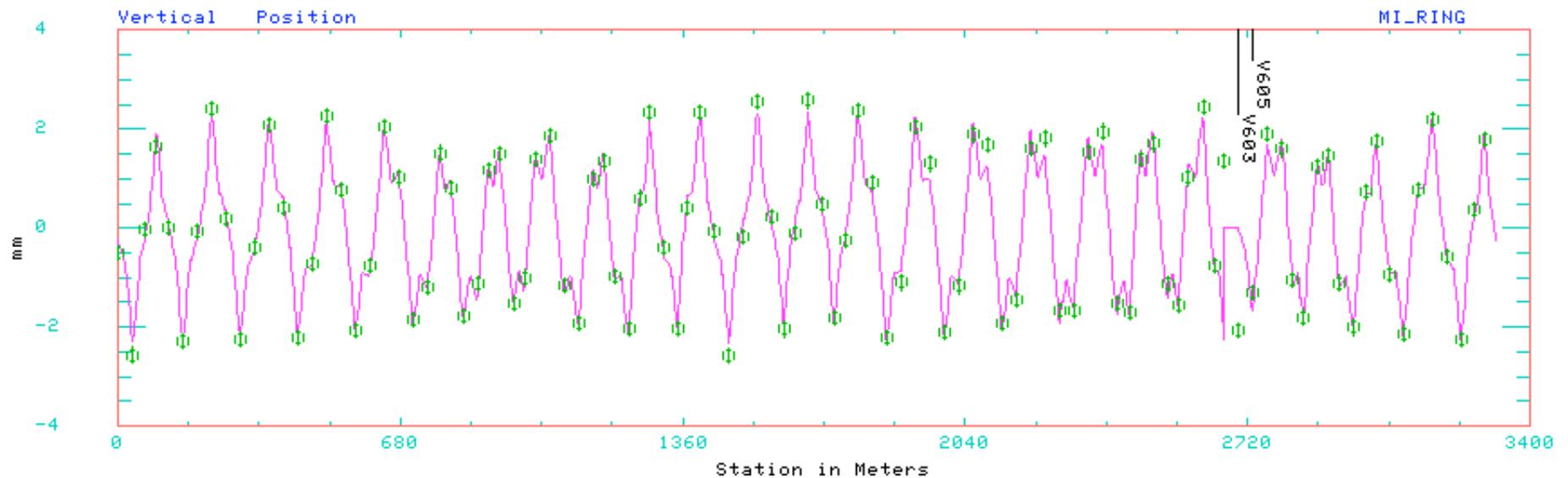
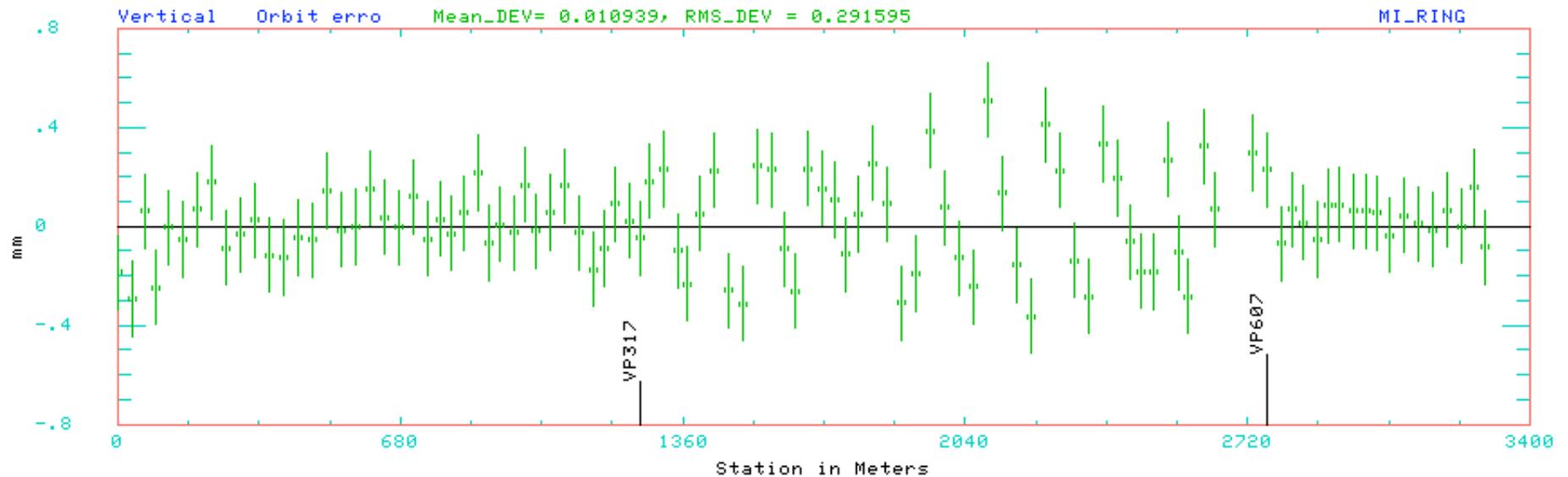
# Matching measured beta



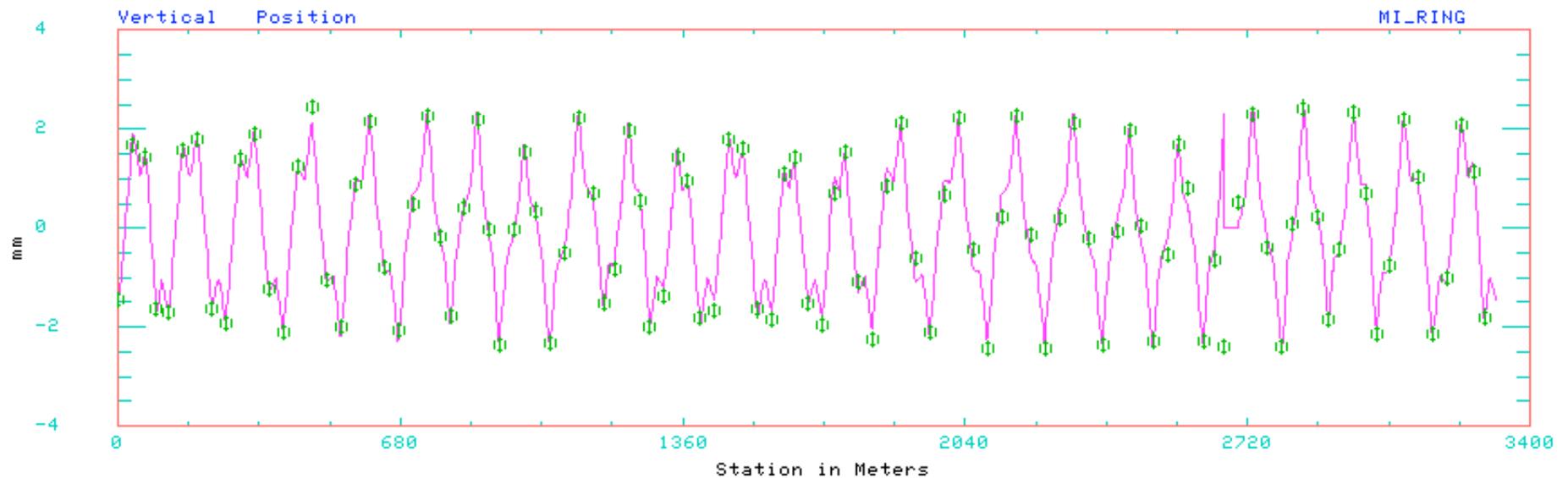
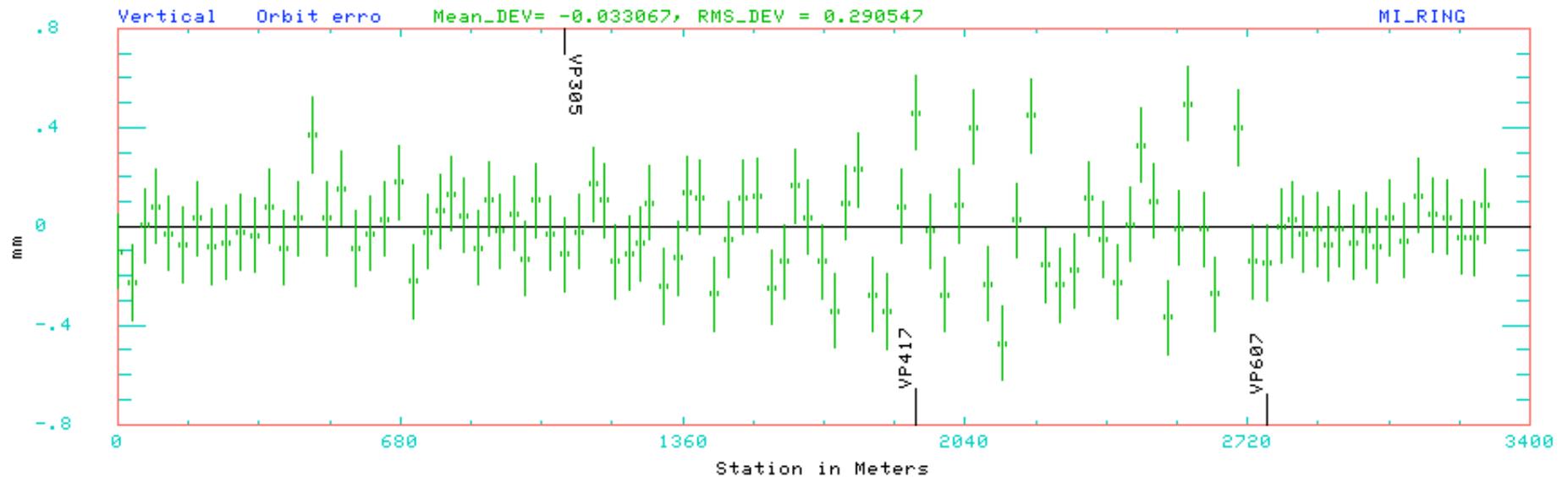
# Phase advances



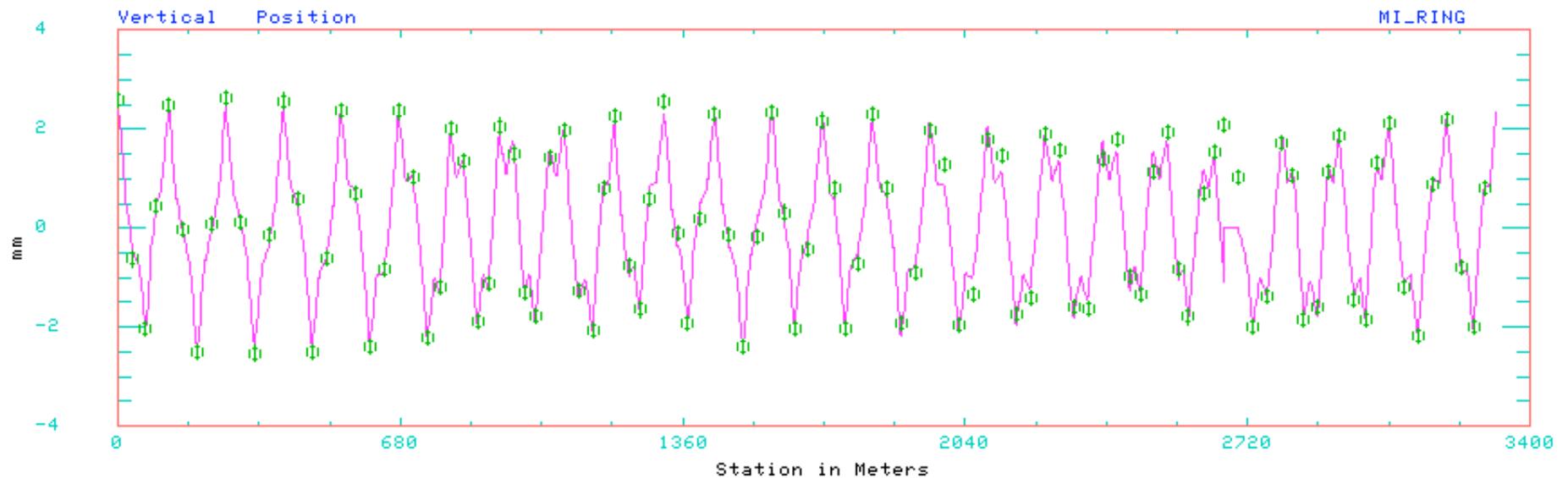
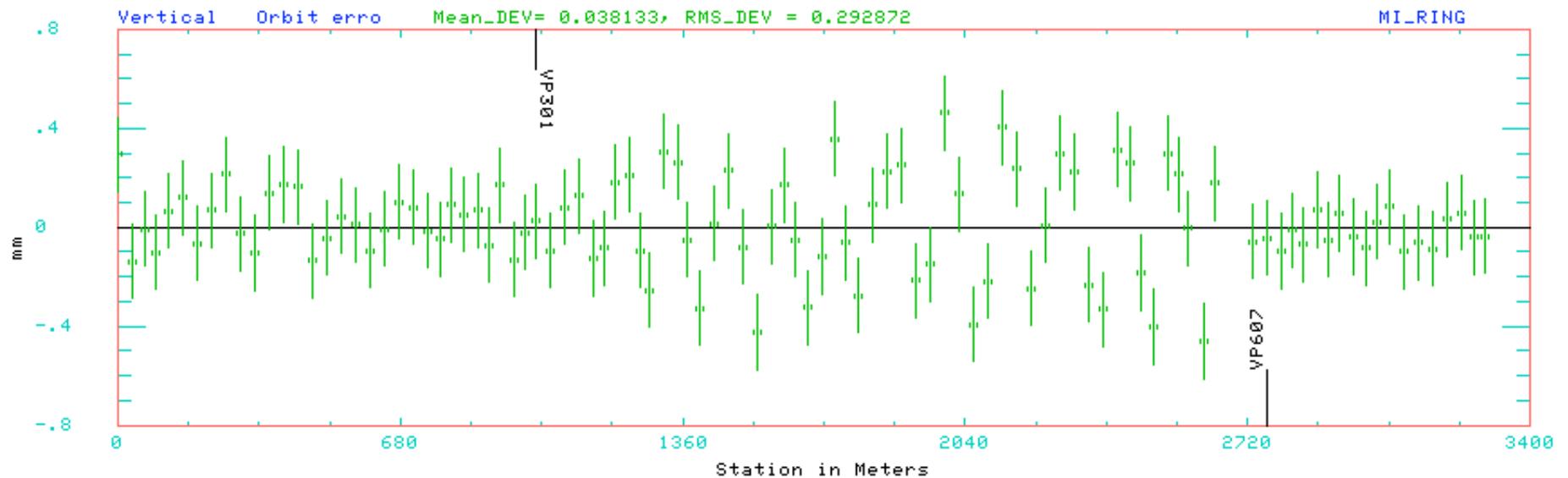
# Vertical orbit and deviation, turn# 120



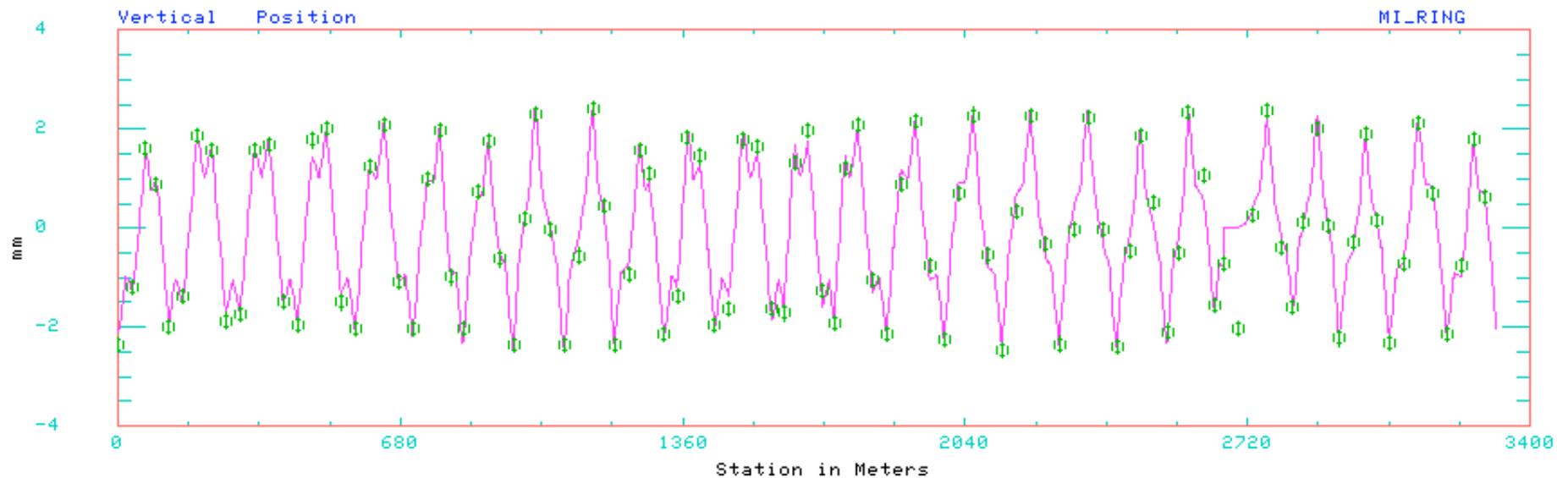
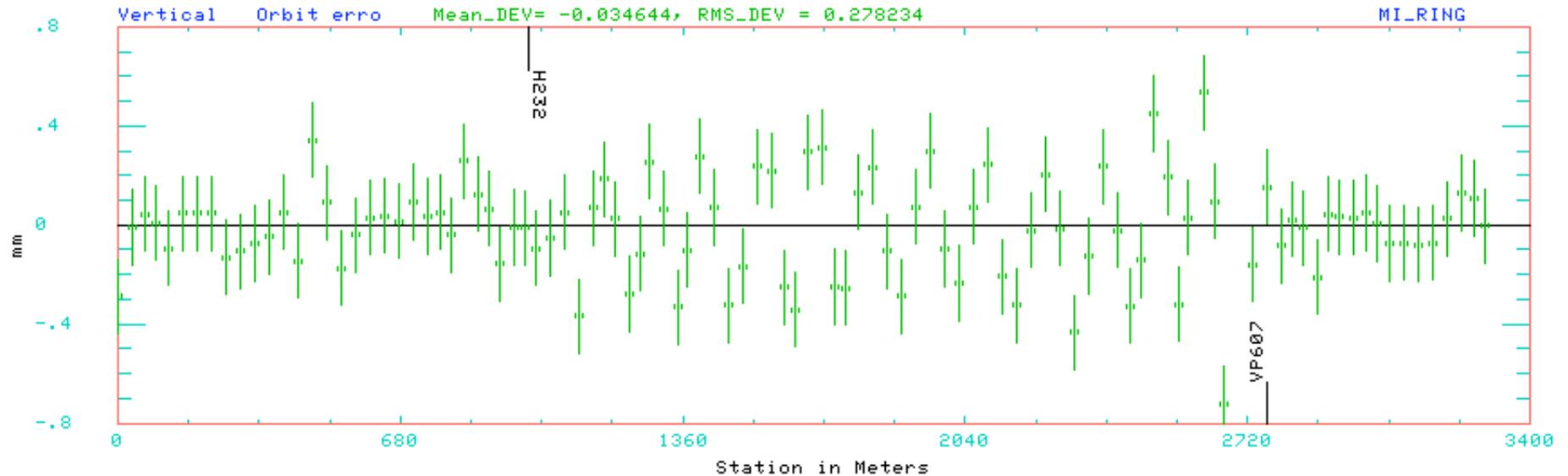
# Vertical orbit and deviation, turn# 121



# Vertical orbit and deviation, turn# 122



# Vertical orbit and deviation, turn# 123



# Lattice result

- ❖ Horizontal plane
  - ▶  $> 20\%$  in  $\Delta\beta/\beta$
- ❖ Vertical plane
  - ▶  $< 10\%$  in  $\Delta\beta/\beta$
- ❖ Adjusting trim current on WQB
  - ▶ Horizontal error reduced to just around 10%.
  - ▶ Vertical error increased only slightly.
- ❖ Problems
  - ▶ Horizontal beta wave.
    - WQBs not likely the sources of error.
  - ▶ The drop in vertical plane phase advance
    - Between MI 229 and 413 locations.

# Next

- ❖ Try taking data later in the cycle
  - ▶ at 2.6 second
  - ▶ Transient effect no longer exist.
- ❖ Change QD turn-on order
  - ▶ Takes about 1 minute to change.
  - ▶ Not a big deal
    - According to Steve Hays.
- ❖ Applied correction
  - ▶ Raise vertical tune.
  - ▶ Harmonic quads
  - ▶ Trim coil in WQBs.